Text Creation	3DO Font Editor	Various desktop publishing packages, such as MacWord
Video Conversion (and compression)	3DO Digitizer	Quicktime tools for Cinepak conversion, such as ConvertToMovie and MovieShop from Apple
	3DO FilmToMovie tool to convert a QuickTime-CinePakmovie into the 3DO format.	C-Cube Encoding Station for MPEG1 encoding
Image Conversion	PPM Translator	DeBabelizer
	Photoshop Plug Ins	
	DeBabelizer 3DO Plug ins	
	Director Extractor*	
Audio Conversion	Soundhack	
Adding Interactivity :		
Authoring	Macromedia Director*	
	Extractor (Extractor avail 8/31)*	
Programming	3DO C Compiler	
	3DO Debugger	
	3DO Linker	
	3DO Assembler	

*These tools will be available in the 3DO Authoring Toolkit shipping 7/15/93.

3.4 Content for Hotel Based Test

The 3DO technology has the capability to provide a wide range of multimedia software. Because of the realism of the imagery and the interactive capabilities, the 3DO technology would be ideally suited for the hotel-based interactive services that US West has been testing in San Francisco area hotels. Interactive shopping services that show real store walk-throughs and real world images of the shops and sites around the area would not only be more realistic and have faster interactivity, but would also be easier to develop using the 3DO technology than with other alternatives.

Due to US West's interest in developing interactive content for a "Spectravision" type service, 3DO will commit to provide programming resources and 3DO Interactive Multiplayer units for a trial service in a San Francisco based hotel location. 3DO will augment US West's human interface and art development team with 3DO knowledgeable programmers. The number of programmers assigned will be dependent on the makeup of the US West team and the number of interactive products that US West is interested in developing.

At a minimum 3DO will commit 2 programmers to work on an interactive shopping service, converting the current CD-I based products being used by US West into a 3DO environment. This conversion would include augmenting the products with higher quality imagery if such imagery is available. Working with 3DO to develop content for this test will help US West come up the learning curve on the 3DO content creation process. It will also provide content for the February trial and will provide a test bed for these services prior to the February trial. 3DO is committed to providing the resources to help US West meet a December time frame to begin a test in a San Francisco hotel location.

3.5 Resource Commitment for Content Development

Task	Type	Number of Personnel
On Screen Program Guide	Programmer	1*
"Spectravision" Content Authoring Toolkit	Programmer	2*
	Product Manager	1
	Programmer (other ATK tools)	1
	Programmer (Director Extractor)	1
Content Library	Product Manager	1
	Programmer (Content Browser)	1
	Content Acquisition/Categorization and Processing	3

* These are resources that will be dedicated specifically for US West. All other resources are already dedicated to these tasks.

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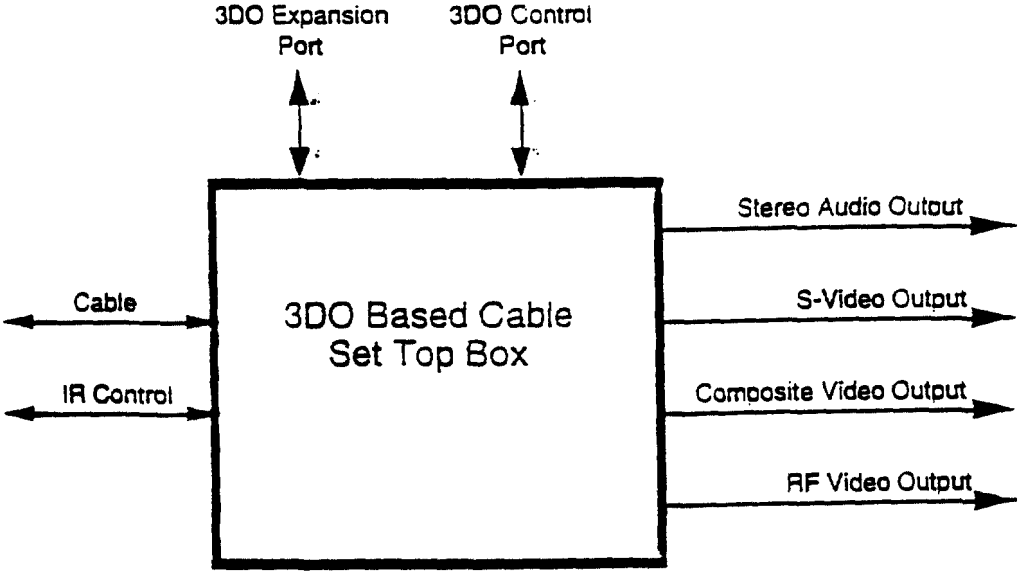
4. PROPOSED 3DO HARDWARE DESIGN

4.1 Design Overview

This section gives a brief overview of a proposed design for a 3DO based Cable Set-top Box (STB). The proposed design is separated into two major parts: 1) portion of the design provided by the 3DO Company, 2) portion of the design provided by either SA or GI.

A diagram showing the inputs and outputs of the 3DO Based Cable STB is shown below.



The primary connections provide by the STB are:

- Single COAX Cable connection for connection to Cable Network
- Single COAX Cable connection for output to the TV (audio & video) RF modulated.
- Stereo audio output for connection to either TV or Stereo system.
- S-Video Output for connection to the TV
- Composite Video Output for connection to the TV
- IR remote Control
- 3DO Standard Expansion Port
- 3DO Standard Control Port

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In discussions with both companies, we have agreed that to meet schedule dates, each company will need to provide the core design for the portion that represents each company's strength. The diagram below (The 3DO Based Cable STB) shows the portions of the design provided by either GI or SA. The portion labeled "3DO Technology for Cable STB" is provided by 3DO. The shaded portions indicate parts that could be added at US West's option.

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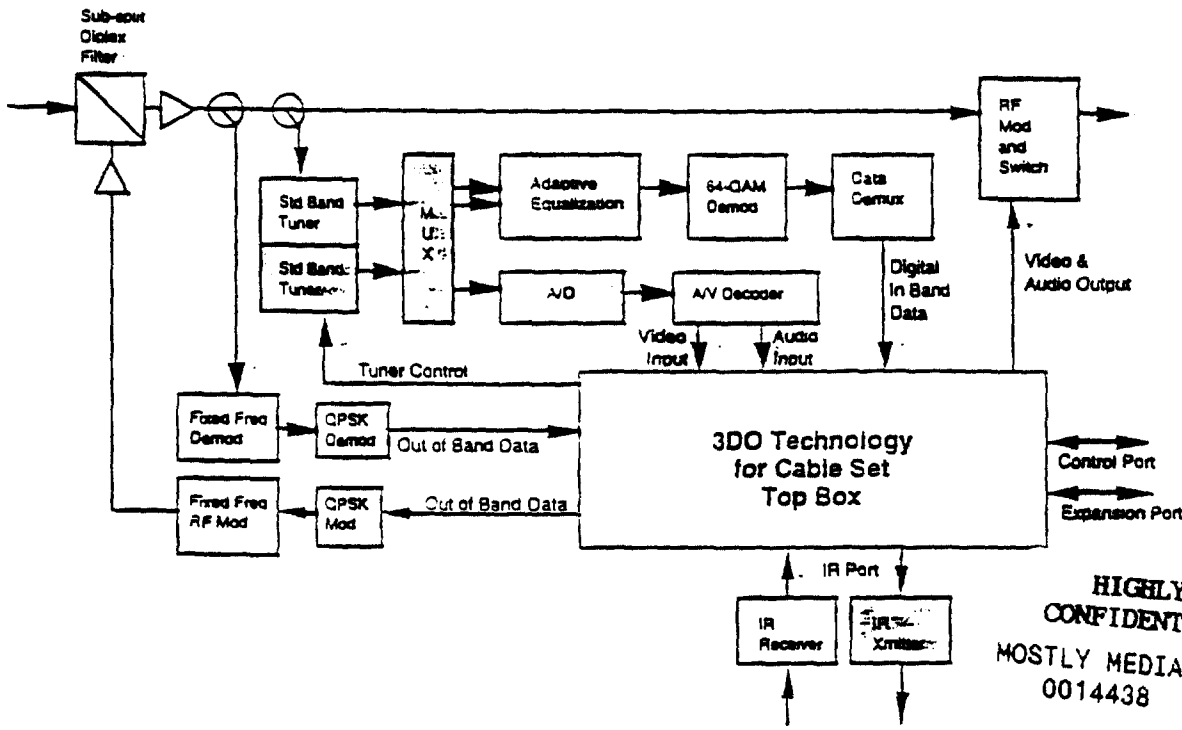
3DO Based Cable Set Top Box



The STB includes either one or two tuner circuits. Either solution could be supported by the 3DO Technology. They gray boxes in the drawing above indicate optional portions of the design. If the two tuner solution is chosen a MUX should be provided to obtain maximum flexibility in directing the two channels. The Tuner is controlled via a digital interface from the 3DO Technology. 3DO envisions a flexible interface which could adapt to either SA or GI's tuners.

There are two primary decoding paths provided in the STB. The first path is used for analog video display and delivers "Video Input" and "Audio Input" to the 3DO technology. SA or GI would provide a design to separate the audio and video signals and deliver to the 3DO system the analog data. The 3DO Technology will digitize these signals and process them appropriately for display. Other operations can also be performed on this video and audio by the 3DO Technology because the 3DO system can treat digital video and audio the same as any other image or sampled audio.

The second decoding path is used for digital data. It delivers the "Digital In Band Data" to the 3DO technology. Its expected that SA or GI would provide a digital demodulator and error correction circuitry. 3DO would bring the data into the 3DO Technology for decompression and processing. This data would typically be compressed video (MPEG I) or computer program data.

The basic STB diagram includes the Out of Band Data communications. The out of Band data modulation and demodulation would be provided by either GI or SA. The 3DO Technology would be capable of digital transmission and reception of this data. It could be used for nearly any purpose by the 3DO Technology.

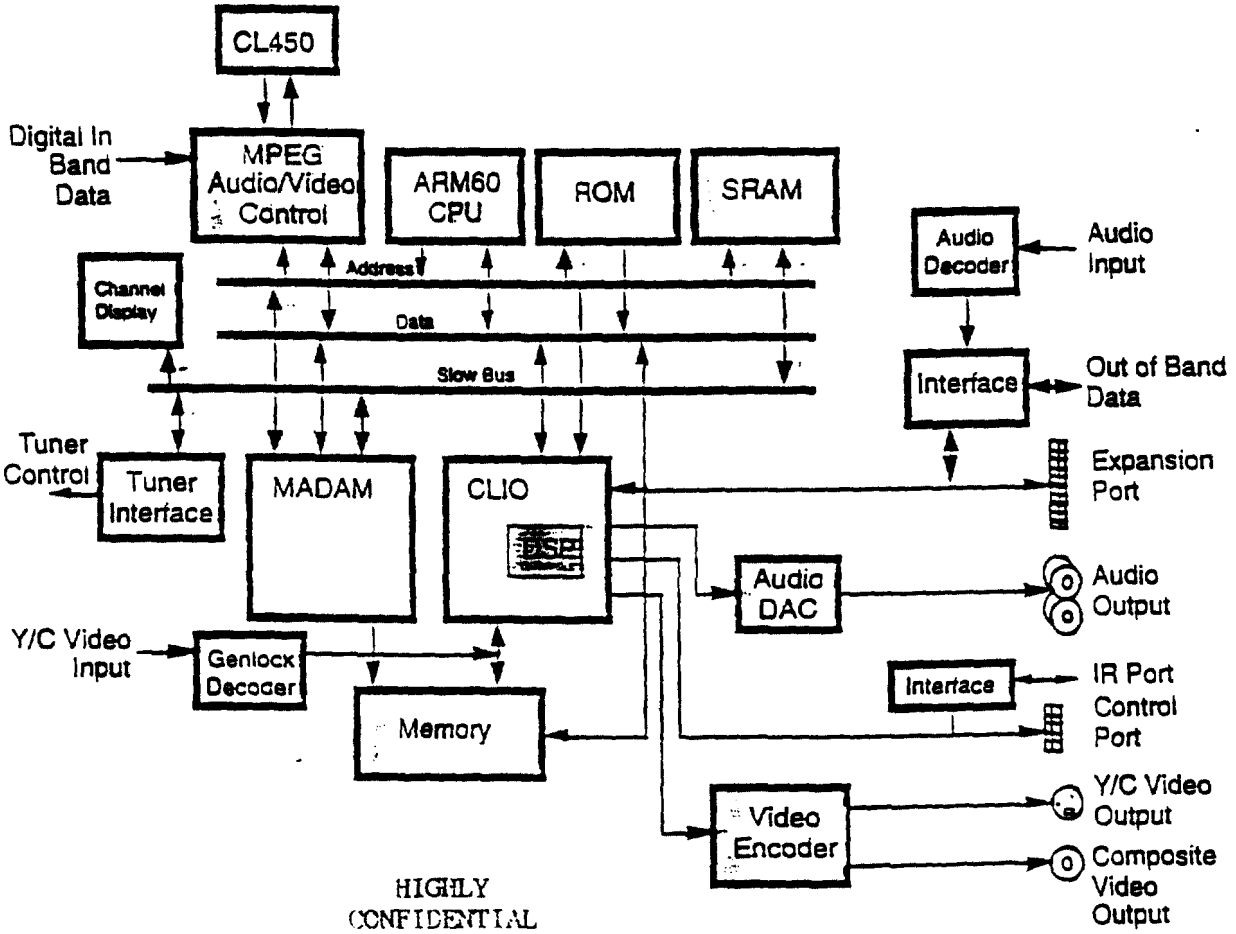
The 3DO Technology provides a flexible "Video and Audio Output" system. A large number output types are supported. The primary connections summary (above) describes the proposed inputs and outputs. Other input and output features could also be provided. A bypass switching mechanism could be provided for RF signals.

The 3DO Technology will incorporate a mechanism for interfacing to an SA or GI IR Remote Control. An optional IR "blaster" can also be provided. The interface provided by the 3DO Technology will be flexible and could support a number of different protocols.

3DO Expansion Port and Control Port are standard ports for which 3DO has developed a large number of peripherals. These ports support devices such as expansion CD-ROM drives, Control Pads, Keyboards, Mice, Trackballs, 3D Glasses, and others.

An expanded diagram of the 3DO Technology is shown below. The gray blocks in the drawing are portions of the design which 3DO has previously developed and tested. The white blocks are blocks which 3DO is either currently developing or would develop for the STB.

3DO Technology for Cable Set Top Box



A description of each of the major blocks in the 3DO design is given here:

- CL450. This chip performs the MPEG1 video decompression.
- MPEG Audio/Video Control. This is a small sub-system which controls the MPEG video decoder (CL450), interfaces the decompression hardware to the 3DO internal busses, and directs data to either the system or to the CL450 based on the data type. It also performs MPEG audio decompression.

- ARM60 CPU. This is a low cost RISC CPU which performs program control functions in the 3DO system.
- ROM. This provides the program code necessary for the ARM60 to operate.
- SRAM. This is a battery backed up SRAM which stores parameters and data even if power is removed from the system.
- Audio Decoder. This converts analog data into digital data for processing and output by the 3DO system.
- Interface for Audio Decoder and Out of Band Data. This block performs simple protocol conversion to bring the data into the 3DO system.
- Tuner Interface. This is a simple digital or analog interface for sending control information to the tuner circuits.
- MADAM & CLIO. 3DO custom chips which perform graphics, video, audio, and math processing. They also interface to the many 3DO ports and the memory system.
- Audio DAC. Provides stereo CD-Quality audio output. These can be mixed to mono and mixed with Video to provide RF type output.
- Genlock Decoder. This is the Analog Video input system. The Genlock Decoder will digitize the analog video stream and convert it into a digital stream for use and display by the 3DO system.
- Memory. This is the display and processing memory used by the 3DO system. From 2 to 16 MBytes can be supported.
- Interface for IR. This is a simple interface for obtaining input from an IR remote control. Its design would be flexible enough to support a large number of IR controllers.
- Video Encoder. This is the portion of the system which generates Video signals for output to the TV. A number of output types are supported.

Potential Optional features:

- Channel Display. This is an optional display which could show current channel numbers or more complex data in addition to on screen displays. A large number of options could be supported or implemented.
- CD-ROM Drive. A 3DO standard drive could be used in the early stages of the trial for loading software during testing of the network. In addition, throughout the trial it could be used to test market applications that use local CD data along with network access.
- MTS Stereo. Stereo decoding could be presented to the baseband audio outputs and if desired, stereo remodulation could be added to the RF Modulator.

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4.2 Hardware Tasks

The development of the 3DO STB for the US West cable trial involves several tasks; completion of the STB design itself, the adaptation of 3DO's existing Development Station to enable software developers to modify content for an interactive network based platform, and the support of the manufacture of the STB.

As it exists today, the 3DO system is lacking only a few features required for the STB application. The major tasks are: Redesign of the video decompression subsystem (if required) and integration of the design with GI or SA.

4.2.1 Hardware Task - Video Decompression Module Design

US West has a choice of three approaches to take for the decompression technology to be used for the trial. Each of these choices has a different impact on developing the STB solution. Each of these approaches will require the following modifications to the video decompression module:

- Modify the decoder interface chip to interface with the selected decompression chip. This task has been completed for the CL450.
- Modify the decoder interface chip to interface with the selected analog to digital video decoder chip.
- Modify the decoder interface chip to interface with the selected data demodulator.
- Modify "slipstream" to allow full frame capture of digital or analog video.

CL450

Given that the CL450 is an MPEG1 solution that is fully compatible with MPEG2, content developed for a CL450 solution would be fully compatible under a future MPEG2 based solution. For this reason 3DO recommends an MPEG1 based set-top solution. Additionally, since a significant portion of the work has already been completed for the CL450 and because it is a lower cost solution than other MPEG1 alternatives available today, 3DO recommends the CL450 as the solution for video decompression for the Omaha trial. Choosing the CL450 will also offer synergy with the consumer electronics market, since this chip has been selected for the MPEG1 add-on peripheral to the 3DO Interactive Multiplayer as well as other potential high volume products. This will allow US West to take advantage of the content created for this marketplace and the parts cost reductions provided by this market.

3DO has designed a CL450-based video decompression module. This module would require a small amount of redesign to allow it to interface directly to the digital tuner and discriminate between compressed video data and other types of data. At US West's request, 3DO will design a CL450 Decompression Module for the 3DO STB at no cost to US West, SA or GI.

CL950

If US West chooses CL950 based video, 3DO can support this choice with the help of SA and C-Cube. 3DO has evaluated the CL950 and believes that it is possible to integrate this chip into the 3DO system. At US West's request, 3DO will design a CL950 Decompression Module for the 3DO STB. Selection of the CL950 for the trial will result in an incremental resource expenditure by 3DO which is not currently part of 3DO's strategic plan.

Digicipher

The Digicipher I technique used by General Instrument is not based on any industry standard decompression chips. Since this solution is not compatible with MPEG2 or even Digicipher II, the content developed for a Digicipher based platform would not be compatible when moving to an MPEG2 based system. For this reason 3DO would not recommend the use of this technology for the trial. However, if US West chooses to utilize this solution, 3DO will support this choice. 3DO has not investigated this solution in detail, however a rough estimate of the schedule and resource requirement for implementing this solution is a 4 to 5 person-year effort. At US West's request, 3DO will work with GI to integrate the Digicipher implementation into the 3DO design. Selection of Digicipher for the trial will result in a significant incremental resource expenditure by 3DO which is not currently part of 3DO's strategic plan. Because both the hardware design and the software and content developed for a Digicipher based solution would be solely for the purposes of this trial, 3DO would provide this incremental engineering effort at cost to GI.

4.2.2 Hardware Task - STB System Design

The system design consists of integrating the 3DO system with either the GI or SA systems. 3DO will work with GI or SA to determine the best way to manage the schematic, PC layout, industrial design, product design, thermal management and EMI issues related to the design of the STB.

4.2.3 Hardware Task - Scientific Atlanta and General Instrument Mutual Support

Close collaboration with whomever US West selects as the STB integrator is critical to the success of the project. 3DO will assist either SA or GI in partitioning the design, selecting components and vendors and coordinating manufacturing. 3DO has extensive experience with transferring 3DO designs to manufacturing companies.

4.2.4 Hardware Task - Network Emulator

This device is used for software development to emulate the control interfaces and data flows of the eventual system. This device will be used in conjunction with a modified 3DO Software Developer Station to allow software to be developed before the final integration of the system. This will also provide title

developers with a means to characterize the control and performance characteristics of the cable environment.

4.2.5 Hardware Task - Software Development Environment

The 3DO Developer Station design will be modified to include the Network Emulator. 3DO will manufacture this system and make it available to 3DO developers developing titles specifically for the cable trial environment.

4.2.6 Hardware Task - Video Encoder Environment

3DO is collaborating with C-Cube on a low-cost high quality real-time 3Mb/s MPEG1-based digital video encoder. If the CL450 is selected as the video decoder, this video encoder may be useful for encoding and storing video materials on the video server.

4.2.7 Hardware Task - Infrared Controller Design

Some type of interface to the Infrared Controller will be required. The specific design will be developed in conjunction GI or SA.

4.3 Hardware Design Schedule

The following schedule assumes that the STB vendor selection will be made by end of June.

7/1/93 -
- Begin specification for Decompression Module design.
- Begin specification for STB.
- Begin specification for Software Development Environment.
- Begin specification for Network Emulator.
- Begin specification for IR Controller

8/1/93 -
- Design Reviews/Begin DM, STB, SDE, IRC and NE designs
- Video encoder prototype complete

9/1/93 -
- Complete SDE and NE design and debug.
- Begin network software integration.
- Complete STB schematic, begin PCB layout.

10/1/93 -
- Complete Decompression Module design review.
- Complete IRC design review
- Complete STB PCB layout, begin fabrication.
- Video encoder station available to developers.
- Demo network emulation of VOD application.

10/15/93 - Pilot production of SDE for 3DO software licensees.

11/1/93 - Prototype silicon and STB debug start.

12/1/93 -
- Complete STB debug.
- Integrate STB in US West lab.

1/15/94 - Begin production of trial Set Top Boxes at SA or GI.

2/1/94 - Begin Omaha trial deployment

4.4 Hardware Resources

4.4.1 - Hardware Resources - VLSI Design

Assuming the CL450 is used for video decompression, the modification of the existing 3DO CL450 design to allow for analog data insertion and digital data discrimination will require 4 engineers for the duration of the development phase of the project. Use of the CL950 will require a 5th hardware engineer and one extra software engineer above the requirement for the CL450. Use of the GI Digicipher technique is estimated to be a 4-5 person-year effort.

Additionally, 3DO has a 10 person VLSI team at work on an integrated 3DO chip that will be ready for Cable trial deployment by the middle of 1994.

The resources for the CL450 version of the STB have been identified and will all be dedicated to the project by the end of July. The system architect has been on the project for over a month and the VLSI project leader is the same person who led the successful development of the production version of the silicon for 3DO's stand alone product. The team will consist entirely of VLSI engineers with extensive experience with the development of VLSI for graphics and video applications.

3DO has all required design workstations and tools and has in place a proven methodology for rapid development of VLSI of the type required for the trial deployment.

4.4.2 Hardware Resources - STB System Design

The system design will be done in conjunction with SA or GI. It is anticipated that one 3DO engineer will be dedicated to this task. This engineer has been identified and will be available by the end of July. It is anticipated that the development of a schematic and PCB design will require less than 100% of this resource. Additionally, there will be an engineer dedicated to supporting SA or GI directly.

4.4.3 Hardware Resources - Development System and Network Emulator Design

The Development System and Network Emulator will be designed by a systems engineer in 3DO's Development Systems Group. This effort will be under significant time pressure as it will quickly fall on the critical path for software development. 3DO will dedicate any necessary technician support to allow for rapid prototyping of the cable development environment for software.

4.4.4 Hardware Resources - Video Encoder Station Design

3DO is collaborating with C-Cube on the development of the hardware, software and algorithms used for high quality video compression at 3Mb/s. This effort consists of three software and one hardware engineer.

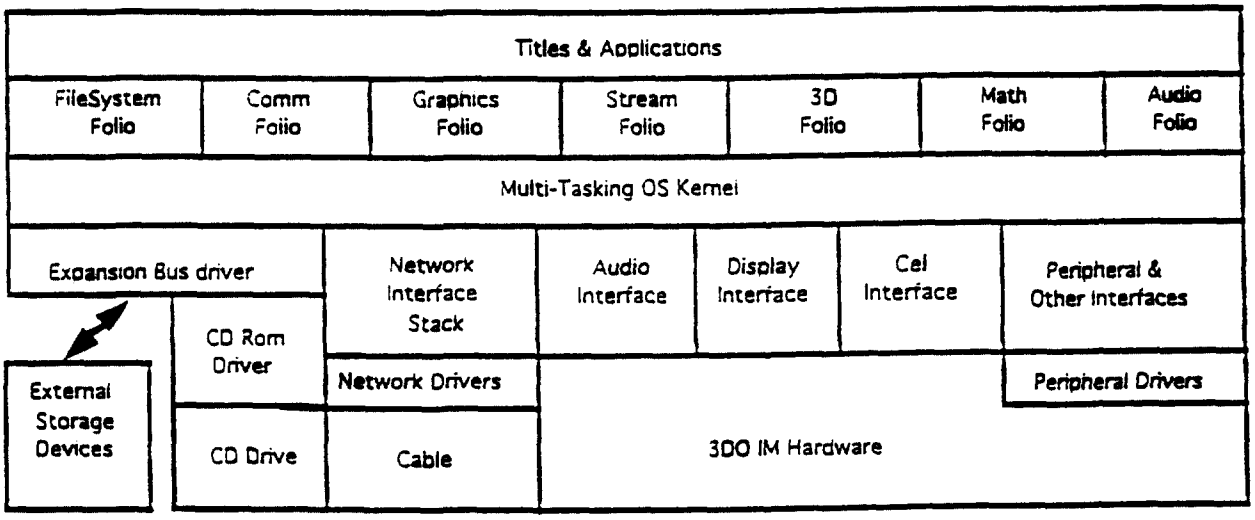
4.4.5 Hardware Resources - Infrared Controller Design

This effort will be staffed by 1 hardware and 1 software engineer and will take approximately 3 months to complete.

5. PROPOSED 3DO SYSTEM SOFTWARE DESIGN

5.1 System Software Design Overview

The Portfolio operating system's File System Folio is designed to provide a consistent file management API to applications, while allowing access to a number of different file system formats and layouts. Files are identified by a pathname (similar to a UNIX pathname). Once opened, a file can be read, written, and manipulated using the standard Portfolio I/O system calls and techniques. The File System Folio (and the File Driver incorporated into it) are responsible for mapping the API semantics into the operations required by the underlying file system structure.



There are three different file system families currently defined:

- The Opera file system format. This is a hierarchical file system structure, analogous to Mac HFS or UNIX BSD Fast File System. It is optimized for use with CD-ROMs, but can support filesystems on ROM and RAM media as well. It supports data replication (the "avatar" system) to minimize CD-ROM seek time and increase data reliability, in a fashion which is completely transparent to programs accessing files. It is currently a read-only file system.

- The Macintosh "remote" format. This file system accesses a hierarchy of folders and files on a Macintosh system being used to develop software for the 3DO environment. File I/O requests are transmitted via an optical link to the Macintosh-based 3DO Debug program for execution. Programmers can make files available to their 3DO programs by simply "dragging and dropping" them into the Macintosh "remote" folder. It is a read-only file system.

- The Road Kill file system format. This is a "flattened" (non-hierarchical) file system which is used to store files in the 3DO system s nonvolatile RAM, or on a memory plug-in cartridge. It is implemented as a linked list of blocks of contiguous storage on the underlying medium (usually RAM or NVRAM, but not necessarily so). Files may be created, deleted, resized, read, and written.

5.2 System Software Requirements

We intend to add support for additional file system types (either on local media, or accessed via a network connection of some support) within this framework based on US West's selection of a server and database systems. We will add support for a network-based file system, specifically:

- Identify the mechanisms used to identify specific files on a network-mounted file system.

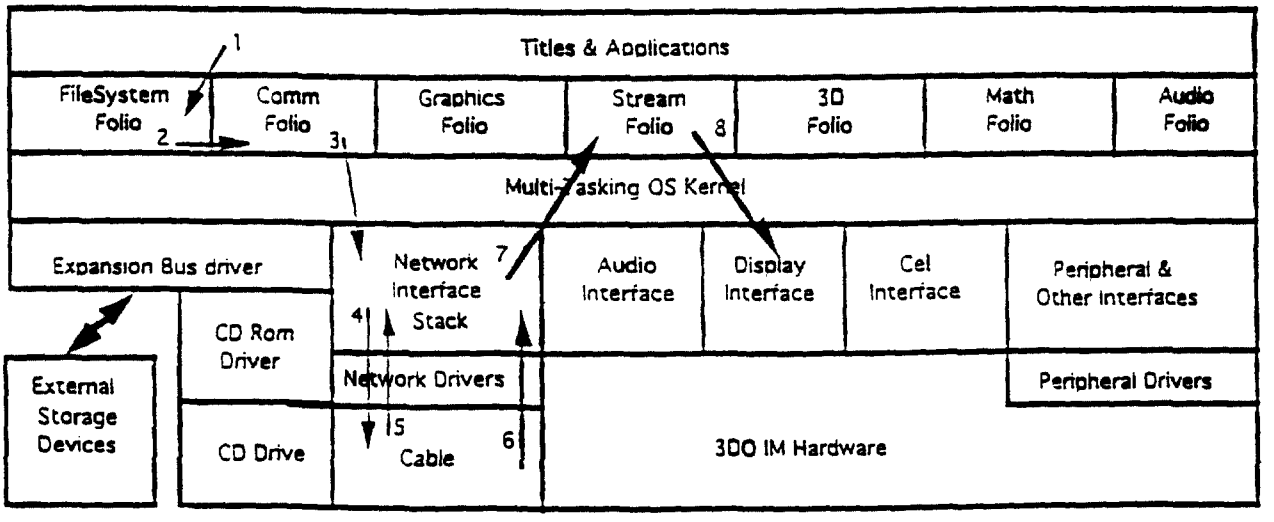
- Define a method for mapping a Portfolio file identification (that is, a pathname) into the format required by the network file system.

- Identify the fundamental operations used to access and manipulate files on a network file system.

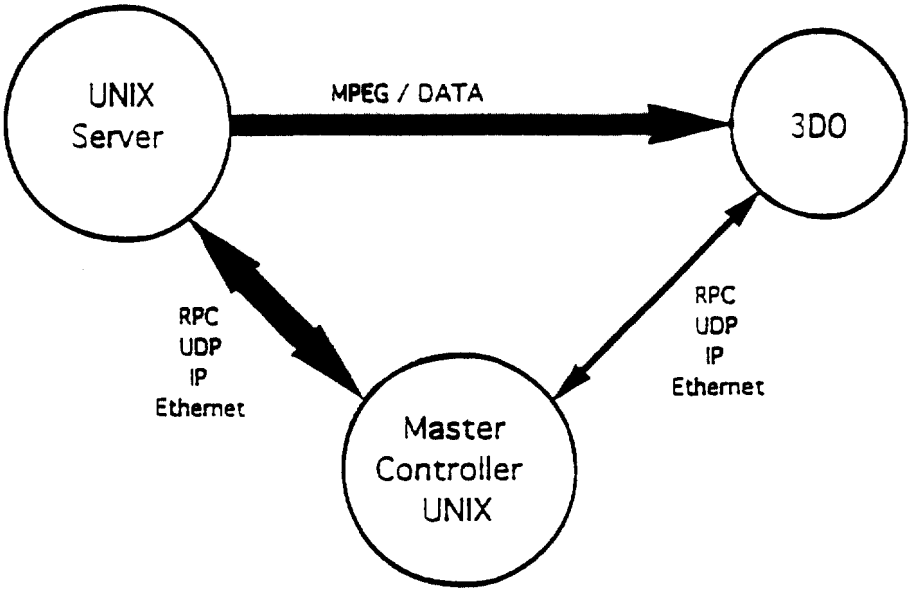
- Define a mapping between the Portfolio I/O system functions, and the corresponding operations on the network-based file system.

- Implement a filesystem-specific suite of functions, which implement the mappings between the Portfolio filenames and functions, and the file identifications and functions used by the network file system. These functions will call upon the services of lower-level Portfolio system services, such as device drivers, the Communications Folio, etc.

For example, since we are assuming a UNIX based server for the trial, we propose to add support for the industry-standard Network File System (NFS) to the Portfolio environment. NFS uses a client/server protocol. Requests from a client system (steps 1 thru 4) are transmitted to a server via RPC (Remote Procedure Call) services, which in effect permit subroutine calls to be issued across a network connection. In order to perform I/O on a file, a client issues an RPC to look up a specific file by name: it receives in return (step 5) a numeric identifier known as a "file handle" which can be used in subsequent I/O requests. To actually read or write data to or from a file, the client issues another RPC and passes the file handle and other data as parameters to the RPC. The server performs the I/O on behalf of the client, and returns any results (data and/or an error code) as the result of the RPC (steps 6 thru 8 for video).



The RPC system used by NFS transfers data across a network by using the UDP/IP protocol stack, or (in principle) any other protocol stack which implements a "best efforts" datagram delivery service. UDP and IP provide some level of datagram correctness checking, and the RPC layer provides additional error detection and validation. As a result, NFS can run reliably over network connections which are less than fully reliable.



Using a network-based file system, it will be possible for 3DO programs to be run "across the network". They can be stored on a central file server, "mounted" over the network, and executed just as if they were stored on a local 3DO file system. The File Folio will fetch the programs from the server when the programs are launched, and can also load code overlays from the server upon demand. Except for the time delays introduced by the network connection and server, execution of a network-based program should be identical with the execution of a locally-stored copy of the same program.

5.3 Network Software Architecture

5.3.1 Software Architecture - The Layers of Network Software

The layers of network software are defined starting at the bottom most layer, which lies directly on the hardware, to the topmost layer where the most abstract level of communications protocol is declared:

- Physical driver layer (media access communications)
- IP layer (Internet Protocol)
- UDP layer (User Datagram Protocol)
- RPC (Remote Procedure Call library)
- File system protocol. Probably NFS (Network File System)
- Conversion from API to NFS RPC's
- Standard API for the application operating system

In order to implement an NFS client on the Portfolio system, it would be necessary to define mappings between the Portfolio semantics and those used by NFS, and then implement these mappings in a set of subroutines. This would involve:

- Porting or implementing an RPC library, which would use the Communications Folio to transfer datagrams between machines.

- Write a new "identify file" subroutine, which (given a Portfolio-style filename) would query an NFS server using RPC and acquire a file handle for the file. This handle would be stored in the "File" data structure maintained by the File Folio and would be used during subsequent accesses.

• Write a new "perform file I/O" subroutine. This subroutine would interpret the Portfolio I/O system commands (read, write, allocate space, add entry to directory) and would construct and issue RPCs to request that the server perform the corresponding actions. The subroutine would also translate the result of the RPC (e.g. error codes, flags, etc.) into the standard Portfolio system format.

• Extend the existing MountFileSystem service, or write a new service, to allow the Portfolio system to make the initial set of RPCs needed to establish a connection with an NFS server and "mount" the NFS volumes as part of the Portfolio file system namespace. The filesystem-mounting service would need to be provided with network-specific information that would be specific enough to allow it to have the Communication Folio establish contact with the NFS server.

• Extend the UnmountFileSystem service to allow an NFS-mounted volume to be removed from the Portfolio file system namespace and to terminate the network connection.

These same basic steps could be applied to almost any sort of file system which the 3DO system might wish to access. In principle, AppleShare or Novell network filesystems, the Andrew file system, or hard-disk-based filesystems such as BSD Fast File System could be supported on the 3DO system using this approach. Both stateless network filesystems such as NFS, and stateful/connection-based filesystems such as AppleShare, could be supported.

Once a file system format is supported through these techniques, any program using the Portfolio file system API would be able to access and manipulate files on filesystems of this type. No program changes would be required.

5.3.2 Software Architecture - Minimum Capabilities of Set-Top Unit

The set-top unit at a minimum must be able to boot up and establish communications over the network to the System manager at the Headend. This includes these capabilities:

- Minimum amount of OS in the ROM to establish communications. (includes the kernel, the file system folio, and the communications folio)
- Download operating system, using portion of one channel data capacity (boot within 10-15 seconds from power up), and then load a startup application.

The set-top unit may contain a startup application in ROM.

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5.3.3 Software Architecture - File System Folio

The 3DO file system provides all the tools required to support the network environment. In particular:

- The file system can live on top of any device driver.
- Files are block oriented, in a fixed block size.
- It's possible to add additional file system types.
- Hooks exist at the upper level of the file system such that the file driver calls on a file manager to create a file, allocate space for this file, set type of file.

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To map into NFS, the file system would create a client server relationship:

- After choosing a server, the server mounts a particular file system and then the file system would mount that using the name of the remote system and its particular file system name.
- The caller receives a handle name.
- The caller then performs arbitrary operations on that handle, e.g. read contents, iterate through directories.
- The caller then contacts the server and asks to mount the file system given an arbitrary pathname.
- File system type called "network". When you open network it looks like you are opening a file, when you open /network you can send out a query.

The current 3DO file system would need to be modified slightly to work with the networking communications folio. These are the required changes:

- Mounting the network as an active file system.

- Implement or port all of the layers up to the RPC and write another file system stub within our file system that can take the 3DO file system calls and the read/write requests and map them into NFS flavored RPC calls, which are then handed off to the comm folio to be broadcast across the network.

5.3.4 Software Architecture - Communications Folio
The Communications Folio provides a uniform and consistent strategy for providing access to various layers in the network hierarchy depending of the requirements of the communication channel.

- Capability to convert I/O requests from 3DO file system request into a Network File System request.
- Ability to receive video and audio compressed data through UDP or IP layer.
- Provide services to allow a network file system to be accessed by the file by RPC.
- Ability to provide signaling and messaging at RPC layer.

5.3.5 Software Architecture - Stream Folio
Under the network model, the stream folio would be extended to be able to receive data from the slipstream data bus also. The stream folio is naturally extensible. The slipstream would simply be another source of stream folio data.

To support the slipstream from the stream folio, we would need to make the following changes:

- Send I/O commands to the comm folio RPC layer to control the remote broadcast of the movie streamed video data.
- Receive movie data from the slipstream driver.

The stream folio already supports the following essential features:

- Receive data streams from any number of sources.
- Parse and decompress audio and video data streams.
- Synchronize the playback of audio and video data streams.

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5.3.6 Software Architecture - Event Broker
The event broker is system code that processes events from user peripherals (in particular, infrared remote controls) and presents them to the application program. The event broker resides at the kernel and folio level part of the OS.

5.3.7 Software Architecture - Kernel
The kernel is 3DO's core layer of system code, which underlies all other system code and all applications. The kernel provides support for multitasking, memory management, interprocess communications, device driver communications.

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5.3.8 Software Architecture - Drivers
The OS supports device drivers, which control specific hardware components. The device drivers germane to the network system include:

- Network Driver (controls communications with the network hardware attached to the expansion bus)
- Slipstream Driver
- Infrared Device Driver (receives input from the infrared hardware attached to either the control port or the slow bus)

5.3.9 Software Architecture - Error Correction
The system provides several layers of error correction, from simple bit error detection at the driver layer to data packet corruption detection at the higher levels. The UDP layer has checksum ability, RPC has some

validity checking, RPC and NFS handle packet checking and retransmission requests. Session control (overall data integrity checking) is at the NFS level.

5.4 System Software Tasks

The major system software tasks that need to be completed are to implement the network layers of the network stack from the Internet Protocol to the Network File System, and to modify the 3DO operating system to support the network environment and communicate with the network file system protocol.

5.4.1 System Software Tasks - Network Stack

The following layers of the network stack will need to be implemented:

- Physical driver layer (media access communications)
- IP layer (Internet Protocol)
- UDP layer (User Datagram Protocol)
- RPC (Remote Procedure Call library)
- File system protocol. Probably NFS (Network File System)

5.4.2 System Software Tasks - File System Folio

The current 3DO file system would need to be modified slightly to work with the networking communications folio. These required changes are:

- Mounting the network as an active file system.
- Implement or port all of the layers up to the RPC and write another file system stub within our file system that can take the 3DO file system calls and the read/write requests and map them into NFS flavored RPC calls, which are then handed off to the comm folio to be broadcast across the network.

5.4.3 System Software Tasks - Communications Folio

A communications folio needs to be developed that has the following capabilities:

- Capability to convert I/O requests from 3DO file system request into a Network File System request.
- Ability to receive video and audio compressed data.
- Provide services to allow a network file system to be accessed by the file.

5.4.4 System Software Tasks - Stream Folio

Most of the stream folio in place, there are some minor modifications that will be required, which will add the capability to:

- Send I/O commands to the comm folio to control the remote broadcast of the movie.
- Receive movie data from the slipstream driver.

5.4.5 System Software Tasks - Drivers

The operating system will need to be augmented with the following drivers:

- Network Driver (controls communications with the network hardware attached to the expansion bus)
- Slipstream Driver
- Infrared Device Driver (receives input from the infrared hardware attached to either the control port or the slow bus)

5.5 System Software Schedule

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The following schedule assumes that the STB vendor selection will be made by end of June.

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Task	Timing
Network Stack	7/1/93 through 10/1/93
File System Folio	7/15/93 through 9/1/93
Communications Folio	7/1/93 through 9/1/93
Stream Folio	7/15/93 through 9/1/93
Drivers	7/15/93 through 11/1/93

5.6 System Software Resources

A total of 8 system software engineers will be allocated to these tasks. This includes 2 engineers to implement the network layers from the IP to the NFS layer, 1 engineer to work on the file system folio, 3 dedicated to the communications folio, 1 working on the stream folio and 1 dedicated to writing the drivers.

6. TECHNICAL SUPPORT

6.1 Pre-Trial Support

3DO is committed to assisting the US West and the chosen STB vendor meet a February 1 trial start date. Therefore, 3DO will provide technical support resources in addition to the resources listed for hardware and software development. At a minimum 3DO will dedicate 2 hardware engineers and 1 software engineer to support US West and the STB vendor.

The software engineer would be used to develop test software required to test and debug the hardware design. This person would also work to educate US West and the STB vendor on the 3DO development environment, the changes being made for the network version, and the network system software.

The hardware engineers will be dedicated to debugging and verifying the hardware STB design. They will provide a full range of hardware technical support, including documenting the interface between 3DO hardware and the STB manufacturers hardware, relaying architectural and design issues between the organizations, coordinating the team to work on these issues, tracking items, getting parts for testing.

6.2 3DO Omaha

3DO will not only devote technical support to ensure that the set-top solution is in place for the February trial, but will also commit resources during the trial to help ensure its continued. 3DO will place a minimum of 5 people on site in the US West Omaha facilities beginning in January 1994 and remaining through August 1, 1994. To provide software application support, the 2 programmers that worked on the on screen program guide will be stationed in Omaha during this period. 3DO will also station the 3 pre-trial technical support personnel in Omaha during this period. In total these resources consist of 2 application software engineers, 1 system software engineer and 2 hardware design engineers.

7. LICENSE CONSIDERATIONS

7.1 Overview

3DO is a technology development and licensing company and does not manufacture or market products that would compete with its licensees. 3DO licenses its technology to both hardware manufacturers and software developers who are developing products for interactive multimedia. 3DO will license its technology to the manufacturers of the STB enabling a high performance interactive environment on the set-top.

3DO will license application software developers who will provide the "content" software. Software will cover a wide variety of applications including, entertainment, education and information.

7.2 License Proposal

3DO will forego all royalties associated with its hardware and software for the purposes of supporting this trial.

7.2.1 License Proposal - STB Hardware License

- 3DO will expedite its licensing agreement process to support the Set-top hardware vendor selected for the project. (Both Scientific Atlanta and General Instruments have received license agreements from 3DO for use of the technology in this trial.)
- 3DO will invest significant engineering resources to support the integration of its technology into the STB.
- For additional services not outlined in this proposal. 3DO will provide those resources at our cost to the hardware vendor designing the STB, unless these efforts are in line with 3DO's strategic direction for the a 3DO based network solution.

7.2.3 License Proposal - Royalties

- 3DO will forego all licensing royalties for purposes of this trial. 3DO will not charge a royalty on the STB to the selected vendor for the duration of the trial. This will reduce the costs to US West of implementing a set-top solution.
- 3DO will also forego content royalties from those 3DO software licensees providing content for the purpose of this trial. This will reduce the costs to US West of implementing interactive services in this trial.

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8. Overall Schedule Commitment

Task	7/1/93	8/1/93	9/1/93	10/1/93	11/1/93	12/1/93	1/1/94	2/1/94
Hardware Design:								
Decompression Module		Design Review		Complete Design				
STB		Design Review	Complete Spec	Complete PCB Layout	Prototype Silicon	Complete Debug		Begin Production SA/GI
Development System		Design Review	Complete Design & Debug	Pilot Production (10/15)				
Tuner Emulator		Design Review	Complete Design & Debug					
Video Encoder		Prototype Complete		Station avail to developers				
Technical Support								Support continues in Omaha thru 8/1/94
Conversion from API to NFS RPC's	??????							
Standard API	??????							
File System Folio	??????							
Communi-cations Folio	??????							
Stream Folio	??????							
Event Broker	??????							
Kernel	??????							
Drivers	??????							
Content Development								
On screen Prgm Guide		start date TBD based on US West needs				Beta for lab test		Final for trial
"Spectra vision" content		start date TBD based on US West needs				In hotel location test		

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9. OVERALL HEADCOUNT SUPPORT FOR US WEST

3DO will commit a total of approximately 27 full time engineers that will be dedicated to the US West trial. In addition there will be other non dedicated 3DO company resources from developer services, developer support, tools support, marketing & sales, operations and administration. The dedicated resources alone entail a dollar commitment of $2 to $3 million dollars. The specific headcount commitments are detailed below, by task.

Task	Headcount Commitment	Type of Resource
Hardware Design		
Decompression Module	4	VLSI Engineers
STB Design	1	Hardware Design Engineer
Development System & Tuner Emulation	1	Hardware Design Engineer
Video Encoder Station	1	Hardware Design Engineer
	3	Software Engineers
Infrared Controller	1	Hardware Design Engineer
	1	Software Engineer
Software Design		
Implement IP to NFS Layers	2-3	Systems Software Engineers
File System Folio	1	Systems Software Engineers
Communications Folio	3	Systems Software Engineers
Stream Folio	1	Systems Software Engineers
Drivers	1	Systems Software Engineers
Content Development:		
On Screen Program Guide	1-3	Application Software Engineers
"Spectravision" Content	2	Application Software Engineers
Technical Support:		
Pre-Trial	2	Hardware Engineers
	1	Software Engineer
In Omaha	2	Application Software Engineers (from on-screen guide dev.)
	2	Hardware Engineers
	1	Software Engineer
TOTAL RESOURCE COMMITMENT	26	(plus 5 continuing after trial start date)

AGREEMENT NO.
LTHGR45773

EXHIBIT 4

3DO SOFTWARE LICENSE AGREEMENT

[See standard license, attached hereto]

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SOFTWARE LICENSE AGREEMENT

BETWEEN

THE 3DO COMPANY
600 Galveston Drive
Redwood City, CA 94063

AND

LICENSEE

Company Name: _____

Address: _____

Contact Person: _____

Telephone Number: _____

Facsimile Number: _____

The 3DO Company ("3DO") enters into this Agreement to license to Licensee ("Licensee") certain technology and trademarks in accordance with the terms and conditions of this Agreement.

This Agreement consists of this cover page, the attached Terms and Conditions, and Exhibit A (Development Environment), Exhibit B (Approved Countries), Exhibit C (Royalties), Exhibit D (End User Notices), Exhibit E (Trademarks and Guidelines), Exhibit F (License Confirmation), and Exhibit G (3DO System Description).

The Licensee's principal place of business is at the above address.

Licensee has read, understands and agrees to the terms and conditions of this Agreement and the undersigned is duly authorized to sign this Agreement on behalf of Licensee.

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THE 3DO COMPANY	LICENSEE
By:_____	By:_____
Name:_____	Name:_____
Title:_____	Title:_____
Date:_____	Date:_____

(Please return three signed originals to the 3DO Company)

SOFTWARE LICENSE AGREEMENT

TERMS AND CONDITIONS

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1.3 "Development Environment" means the Development Environment Software, when used with the Development Environment Hardware.

1.4 "Development Environment Hardware" means the hardware described in Exhibit A. Exhibit A may be amended by 3DO from time to time upon thirty (30) days prior written notice to Licensee.

1.5 "Development Environment Software" means the computer program described in Exhibit A in object code form only. Exhibit A may be amended by 3DO from time to time upon thirty (30) days prior written notice to Licensee.

1.6 "Documentation" means the documentation accompanying the Development Environment.

1.7 "Intellectual Property Rights" means all current and future worldwide patents and other patent rights, copyrights, trade secret rights, and the equivalents of the foregoing under the laws of any jurisdiction, and all other intellectual property rights, including without limitation all applications and registrations with respect thereto, in and to the Documentation, 3DO System, Development Environment Hardware, Development Environment Software and Operating System Kernel, which 3DO owns or to which 3DO has the right to grant licenses of the scope granted herein.

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